

## Vestibular nerve section following previous mastoidectomy

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### Abstract

Vestibular neurectomy is an effective procedure in the management of vertigo due to active labyrinthine disease. Various approaches have been developed for selectively sectioning the vestibular nerve, in order to preserve serviceable hearing and avoid facial nerve injury.

In patients who have a mastoid cavity, from previous surgery for chronic otitis media, the approach to the vestibular nerve has to be modified. Considerations taken into account are cavity infection, hearing status, and the presence of associated loud tinnitus.

Vestibular or vestibulo-cochlear nerve section has been undertaken, by the senior author, in eight patients with a mastoid cavity from previous surgery for chronic otitis media. Translabyrinthine, retrosigmoid and middle fossa approaches have all been used; strategies for selection of each specific technique are considered, and the aetiology of post-chronic suppurative otitis media (CSOM) peripheral vestibular disease discussed.

**Key words:** Vestibular nerve, surgery; Menière's disease; Mastoid, surgery; Otitis media, suppurative

### Introduction

Frequent, severe vertigo and imbalance are disabling symptoms which can result in marked incapacity. Most patients can be managed conservatively with a satisfactory outcome. There are, however, a small number of patients who unfortunately continue to suffer from troublesome and recurrent symptoms in whom vestibular nerve section would provide effective control.

Vestibular nerve section can be accomplished by various different routes. The retrolabyrinthine approach (Silverstein and Norrell, 1982) is probably the one route most commonly used by neuro-otologists. In the presence of a mastoid cavity, however, an alternative technique has to be considered in order to avoid traversing an exteriorised mastoid cavity, and risking contamination of the subarachnoid space (McElveen *et al.*, 1987). If useful hearing remains, both middle fossa or retrosigmoid approaches may be suitable. If there is poor or absent cochlear function, a translabyrinthine approach can be used in conjunction with a subtotal petrosectomy and an external canal overclosure procedure (Parikh and Brookes, 1994). A cochlear nerve section can be carried out concurrently if the patient suffers from associated disturbing tinnitus.

This article is based on a retrospective study of eight patients with incapacitating vertigo and imbalance, and a history of previous mastoid surgery for chronic otitis media, managed by vestibular nerve section. We discuss the different approaches used

and the possible pathogenic mechanisms for endolymphatic hydrops in chronic otitis media.

### Case reports

The data on the eight patients operated upon using various approaches is summarised in Tables I to III. Three cases are now considered in more detail.

#### Case 1

A 52-year-old man, was referred for definitive management of his frequent vertigo. During the last four years he had experienced episodes of rotatory vertigo, every other day, when objects tended to move towards the left side. The attacks were associated with loud tinnitus in the right ear and a feeling of aural fullness. Recently he had experienced two 'drop' attacks. Thirty years prior to this consultation he had undergone bilateral mastoidectomies for chronic otitis media.

On examination he had dry and stable mastoid cavities, and a spontaneous left beating nystagmus. Pure tone audiometry revealed a bilateral mixed hearing loss with a 55 dB and 30 dB sensorineural element on the right and left sides. The conductive loss on both sides was 20 dB. A clinical diagnosis of right secondary endolymphatic hydrops due to past chronic otitis media was made, and in view of the

TABLE I  
RETROSIGMOID APPROACH

Patient/ Age/Sex	Symptoms	State of mastoid cavity	Diagnosis	Operative findings/FU
52/M	V: 4 yrs Objects move R to L Aural fullness: R 'Drop' attacks × 2	Bilateral mastoid cavities Both dry/stable	R 2° Hydrops	Clear demarcation between components of VIIIth nerve, Section complete
53/F	HL: fluctuating, 3 yrs V: 1 yr T: R, 1 yr Aural fullness: R	Infected, Revision mastoidectomy: 3 yrs ago, recurrent X, granulations	R 2° Hydrops	Unclear demarcation between cochlear and vestibular components, but section complete, Post-operation compensation poor due to active contralateral hydrops

V: vertigo; T: tinnitus; R: right; L: left; X: cholesteatoma

patient's disabling symptoms, vestibular nerve section recommended.

A retrosigmoid approach was used to expose the VIIIth nerve in the cerebello-pontine angle, and the vestibular nerve sectioned. He was discharged from hospital on the sixth day and his rehabilitation progressed smoothly. His attacks of incapacitating vertigo abated completely, and he was able to resume full-time work. He has been followed-up for six months.

Case 2

A 51-year-old man, was referred for management of his intractable vertigo. He had a seven year history of recurrent vertigo, occurring every two to three days, and lasting about three hours. These attacks were associated with an hallucination of movement from right to left; right-sided tinnitus and aural fullness. The symptoms had become more severe in the past year. Fifteen years previously he

had undergone a right mastoidectomy for cholesteatoma.

On examination he had an unstable mastoid cavity. Pure tone audiometry revealed a 'dead' ear on the right with normal hearing on the left side. He was diagnosed as having secondary endolymphatic hydrops on the right, and due to the severity of his symptoms and an infected mastoid cavity, listed for a middle fossa vestibular nerve section.

At surgery he was found to have adhesions sticking the nerves together in the internal auditory canal. Careful dissection was therefore required to define the superior and inferior vestibular nerves prior to sectioning which was thought to be complete. There were no untoward post-operative sequelae.

He was free of his disturbing symptoms for two months, but subsequently frequent dizzy spells recurred. Although these attacks occurred everyday, they were much less severe than those prior to his middle fossa surgery, only lasting a few minutes at a

TABLE II  
MIDDLE FOSSA APPROACH

Age/Sex	Symptoms	State of mastoid cavity	Diagnosis	Operative findings/FU
57/M	V: 7 yrs, 2-3 days Objects move R to L T: R, 1 yr Aural fullness: R	Unstable	R 2° Hydrops	Adhesions plastering the nerves in IAC Initially free of V, but attacks recurred with less frequency and severity R. rev. mastoidectomy, Osseous labyrinthectomy 2 months post-operation; V: abated completely
45/M	V: 6 yrs Objects move L to R Tends to fall to R	Stable Mastoidectomy, 8 yrs ago, Posterior SCC fistula	Uncompensated L peripheral vestibular disorder	Dural and temporal lobe herniation into the mastoid cavity Facial nerve bruising, decompressed; no facial weakness post-operation HL: pre-operation 50 dB, post-operation total
44/F	HL: congenital V: 2 yrs Gait: towards L T: R, 2 yrs	Infection ++ Membranous labyrinthine ablation with injection of alcohol: 8 months ago	R 2° Hydrops	Granulations in IAC bleeding ++, procedure abandoned VNS Posterior fossa approach, 4 months later

V: vertigo; T: tinnitus; HL: hearing loss; R: right; L: left; VNS: vestibular nerve section; SCC: semicircular canal; IAC: internal auditory canal; FU: follow-up

TABLE III  
TRANSLABYRINTHINE APPROACH

Age/Sex	Symptoms	State of mastoid cavity	Diagnosis	Operation/findings
48/M	V: 1 yr, everyday T: R, 1 yr HL: Total R	R cortical mastoidectomy ? Labyrinthitis	Uncompensated R peripheral vestibular disorder	CVNS with SP/ECO mass of fibrous tissue in IAC, no discreet nerve
27/M	V: 10 mnths Drop attacks HL: Total L	Stable Partial chemical labyrinthine ablation, 8 months ago	Uncompensated L peripheral vestibular disorder	with SP/ECO
53/M	V: 3 yrs T: L, 1 yr HL: Total L	Unstable Transcanal partial labyrinthine ablation, 2 yrs ago	—do—	CVNS with SP/ECO Lateral SCC fistula sealed with fascia

V: vertigo; T: tinnitus; HL: hearing loss; R: right; L: left; X: cholesteatoma; VNS: vestibular nerve section; CVNS: Total 8th nerve section; SP/ECO: subtotal petrosectomy with external canal overclosure; SCC: semicircular canal; IAC: internal auditory canal

time. His cavity remained unstable and the local infection failed to resolve with intensive medical management. Further surgery was therefore indicated and a right labyrinthectomy with canal overclosure was performed at the same time as his revision mastoidectomy, as it was suspected that his previous nerve section could have been incomplete. He was cured of his symptoms of vertigo and discharged a year later.

### Case 3

A 48-year-old man, was also a tertiary referral for evaluation of recurrent vertigo and right-sided tinnitus. Fifteen months prior to this consultation he was admitted to hospital with symptoms consistent with a right suppurative labyrinthitis. On examination at that time he had a moist perforation of the right tympanic membrane, a 'dead ear' and an unsteady gait. A computed tomography (CT) scan, then, showed opaque cells in the mastoid system with the possibility of an extradural collection near the sigmoid sinus. A cortical mastoidectomy had been performed and granulations were found in the mastoid air cells, but there was no cholesteatoma or labyrinthine fistula.

Due to the severity of his continuing symptoms for more than one year, translabyrinthine cochleo-vestibular nerve section with canal overclosure was recommended. At surgery he was found to have a swollen mass of fibrous tissue in the internal auditory canal (IAO), so that it was impossible to define discrete cochlear, vestibular and facial nerves. The posterior fossa dura was therefore incised to facilitate VIIIth nerve identification in the cerebellopontine angle, and the cochleo-vestibular nerves sectioned in their retrolabyrinthine part. The mass of fibrous tissue was excised from the IAC and the cavity obliterated with a muscle flap and abdominal fat before oversewing the external meatus.

Post-operatively he developed a postaural seroma which resolved spontaneous. Four months after surgery he was free of vertigo and imbalance whilst his tinnitus intensity was markedly reduced.

### Discussion

Vestibular neurectomy is a safe procedure in expert hands, and provides effective relief from refractory vertigo of peripheral origin, in 90–95 per cent of patients (Liston *et al.*, 1991). It denervates the offending labyrinth, thus allowing the central mechanisms to compensate from the asynchronous signals arising from the inner ears.

Selective sectioning of the vestibular nerve can be achieved via a retrolabyrinthine, retrosigmoid, middle fossa or translabyrinthine route. The approach however, has to be modified in patients who have an exteriorised mastoid cavity (McElveen *et al.*, 1987). An infected mastoid cavity is always a cause for concern to a neurotologist undertaking an intracranial procedure because anaerobes are often present (Jokipii *et al.*, 1977). Even a dry exteriorised mastoid cavity can be colonised with bacteria of the external auditory canal (McElveen *et al.*, 1987). These patients, however, should not be excluded as candidates for a vestibular neurectomy solely because of the presence of a mastoid cavity.

Vestibular nerve section via a retrosigmoid approach is a good option in patients with a mastoid cavity. The cerebellopontine angle is reached posterior to the sigmoid sinus. The venous sinus provides a valuable landmark in avoiding opening into the mastoid cavity through a craniotomy opening. Some retraction of the cerebellum is required to visualise the porus acousticus where the vestibular nerve fibres are cephalad to the auditory fibres (Rasmussen, 1940) This approach is not, however, without its disadvantages. Although the plane of cleavage between the vestibular and auditory fibres is usually readily apparent, the distinction is not always ideal. This may occasionally result in an incomplete transection which can lead to persistent or early recurrent symptoms. For a more definite neurectomy the posterior lip of the IAC can be drilled away to expose the discrete superior and inferior vestibular nerves more proximally (Silverstein *et al.*, 1987). The two patients in this study, who had a retrosigmoid neurectomy, reported a complete resolution of their vertiginous symptoms. Drilling of the IAC was unnecessary. Another disadvantage of this approach

is the post-operative, and in some cases long-term pain and discomfort from the incision. This may result from elevation of the trapezius and splenius capitis muscles during the surgical approach. In addition, traction on the dura from adhesions between it and the overlying musculature may play a significant role. For this reason the senior author prefers to cut a limited occipital bone window, and routinely replaces the bone flap over the dura prior to muscle closure.

An alternative approach is the middle fossa vestibular neurectomy (Garcia-Ibanez and Garcia-Ibanez, 1980). Although this technique is extradural, and both vestibular nerves can be sectioned more laterally where they are discrete from the auditory branch, there are certain disadvantages. It is technically a more difficult procedure, and the risk of transient or more permanent facial nerve weakness much higher. Temporal lobe retraction may rarely cause epilepsy, and this risk may be higher in the older patient. There is also a greater chance of inadvertently opening into the mastoid cavity, as the tegmen bone may be dehiscent from previous mastoidectomy surgery. Three patients in the present study underwent a vestibular neurectomy through this route. One patient sustained facial nerve bruising and infralabyrinthine decompression was undertaken at the same time. The procedure proved more difficult in his case as a segment of the dura and temporal lobe had collapsed into the mastoid cavity due to excessive bone removal from the earlier procedure. Pre-operatively he had audible hearing (50 dB), which was totally lost following the nerve section though he had no post-operative facial weakness. Granulations or excessive fibrous adhesions in the IAC were encountered in two of these cases. In the one patient with granulations excessive bleeding occurred and the procedure was abandoned. She later underwent nerve section through a posterior fossa approach.

Recently, we have reported on three cases, who are included in this study, where a translabyrinthine nerve section was undertaken in conjunction with a subtotal petrosectomy and canal overclosure procedure (Parikh and Brookes, 1994). These patients had no hearing on the affected side, whilst the contralateral hearing was normal in all cases. Two of the patients had associated loud, disturbing tinnitus and therefore underwent a total VIIIth nerve section with good symptomatic improvement. This procedure is more complete in that it combines a labyrinthectomy and a preganglionic nerve section. The potential disadvantages are contamination of the subarachnoid space and CSF leakage. A complete subtotal petrosectomy with antibiotic cover prevents the former, and good dural slap approximation reinforced with temporalis fascia and abdominal fat prevents the latter. All the patients had primary healing of the wound, the longest follow-up period being four years. The main advantage of this operation is in giving the patient an ear without a mastoid cavity needing long-term outpatient visits,

and one that does not need to be protected from water when bathing and taking part in aquatic sports.

The association of chronic otitis media with endolymphatic hydrops has been established for some time, though it is infrequently encountered in clinical practice. Meyerhoff *et al.* (1978), in a study of 123 temporal bones with chronic otitis media, demonstrated the presence of hydrops in 17.9 per cent of the cases. Chronic otitis media leading to labyrinthitis causing a sensorineural hearing loss and endolymphatic hydrops has been reported clinically (Paparella *et al.*, 1972). Paparella *et al.* (1983) in their clinical study of 385 patients who had been diagnosed as having Menière's disease, and needing surgical treatment, found 37 (9.6 per cent) candidates with a significant past history of chronic otitis media. The same correlation has also been demonstrated in animal models (Kimura, 1982).

Most speculations on the pathogenesis of Menière's syndrome occurring secondary to chronic otitis media take into consideration the permeability of the round window. Experimental animal studies have shown that bacterial endotoxin from the middle ear can permeate through the round window, leading to an inflammatory response in the inner ear, and the development of endolymphatic hydrops (Kawauchi *et al.*, 1988). Paparella *et al.* (1983), hypothesise that following permeation of bacterial products through the round window, the endolymphatic space is invaded via basilar membrane perforations or the Reissner's membrane. This can change the chemical and physical properties of the endolymph, influencing its production and absorption, and finally leading to hydrops. Another theory, which has been considered, is of chronic otitis media leading to mastoid hypocellularity and concomitant hypodevelopment of the Trautmann's triangle (Paparella 1984). This can disturb the development of the endolymphatic duct and sac, and its blood supply.

Brookes (1989), in a clinical study of five patients with active CSOM and contralateral hydrops, has postulated on a possible immune mediated mechanism. His patients showed a marked improvement in their otovestibular symptoms when measures were taken to treat the active CSOM in the contralateral ear. The role of the endolymphatic sac in mediating an inner ear immune response has been established (Rask-Anderson and Stahle, 1980). An additional role is played by antibodies present in the endolymph and perilymph (Rask-Anderson and Stahle, 1980). A 'primary' response to antigenic stimulation by the inner ear is known to cause mild inflammatory changes and membranous labyrinthitis (Harris, 1983). Subsequent exposures can lead to a much more pronounced 'secondary' response which can cause a decline in cochlear and vestibular function. It is, therefore, possible that in patients with a long-standing history of CSOM, permeation of middle ear antigens through the round window could, in the longterm, induce an ipsilateral immune-mediated endolymphatic hydrops.

In three patients we studied, the vestibulocochlear nerve was found to be enmeshed in fibrous

tissue and granulations. These had to be dissected prior to sectioning the nerve. In addition to the above theories, therefore, it is possible that this could play a role in the pathogenesis of secondary hydrops in some cases. Infection tracking through the mastoid air cell system or inner ear may cause an inflammatory neuritis leading to fibrosis and granulations enveloping the structures within the internal auditory canal. This could compromise the blood supply to the inner ear with the subsequent development of hydrops.

Patients with disabling vertigo from active peripheral labyrinthine disease and a mastoid cavity, although uncommon, can pose difficult management problems. All the cases in this series were in fact tertiary referrals from colleagues. Although the middle fossa approach is very suitable for the management of many types of labyrinthine disease, the frequent finding of internal auditory canal adhesions had led us to prefer a retrosigmoid approach when the hearing is satisfactory. A translabyrinthine approach is preferred when the hearing is poor and when both cochlear and vestibular nerve section indicated, providing the mastoid is stable and free from infection. In the presence of an actively infected cavity, end organ ablation by total osseous labyrinthectomy in conjunction with revision mastoidectomy is appropriate, thereby avoiding the potential risk of bacterial CSF contamination.

Surgery successfully abolished the vertigo attacks in all patients in this study. All except one, who had active contralateral inner ear disease, compensated well and were pleased with their treatment outcome.

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